CRUSH Project

Lee F. Johnson, Brad Lobitz

Ames Research Center, together with the Robert Mondavi Winery (Oakville, California) and Terra Spase Vineyard Consulting (Napa, California), is evaluating the use of geospatial technology (remote-sensing, geographic information systems) in a "precision agriculture" context. In the Canopy Remote-Sensing for Uniformly Segmented Harvest (CRUSH) project, high-spatial resolution multispectral images were collected at midseason 1997 with an airborne ADAR-5500 digital camera system.

In a technology demonstration, an image of a 7.5-acre Mondavi chardonnay study block was processed to a Normalized Difference Vegetation Index to improve sensitivity to grapevine canopy density. The Index values were then stratified and color-coded for visual discrimination. A georegistered output image was delivered to the winery for input to the grower's geographic information system. NASA and winery researchers field-sampled vines within the study block for canopy density (light interception), vine physiology (leaf-water potential, chlorophyll concentration), fruit characteristics (maturity, potential quality), and yield. The grower used a laptop computer with image display and onboard Global Positioning System to physically subdivide (with flagging tape) the study block for harvest based on vine vigor (high, medium, and low). Grapes from each field segment were fermented separately and the resulting wines were formally evaluated by the winery.

Field measurement of canopy density and leaf-water potential agreed well with image patterns of density, which was in turn related to grape maturity and malic acid concentration. Most significantly, the winery realized for the first time "reserve" wine (highest quality and value) from a portion of the study block. In addition to the technology demonstration, Ames staff transferred image processing methods and expertise to Terra Spase, who was then able to add value to the raw imagery and sell the product to some 25 North Coast wine-producing clients. Partially as an outcome of this project, Mondavi Winery has led an effort to establish the Wine Country Geographical Information System, a regional user group dedicated to sharing spatial data and processing techniques.

Point of Contact: L. Johnson
(650) 604-3331
ljohnson@mail.arc.nasa.gov

Modeling Leaf and Canopy Reflectance

Lee F. Johnson, Christine A. Hlavka

The goals of this project are to build a leaf reflectance model (LEAFMOD) that incorporates the absorbance properties of biological chemical components, to test the validity of the model, and to evaluate the sensitivity of canopy reflectance to changes in leaf chemical composition by coupling the leaf model to a canopy model. This research will contribute to a better understanding of the radiative transfer processes of plant canopies and will be useful in interpreting remote-sensing data, that is, images from airborne and satellite platforms, used for ecological and biogeochemical research. The results should be useful in determining the minimum sensing requirements for future high-spectral-resolution instruments.

The LEAFMOD computer simulation program was developed to run in two modes: (1) a forward mode that simulates leaf reflectance and transmittance given the optical properties of the leaf material, and (2) an inverse mode that computes the optical properties given reflectance and transmittance by finding values that reproduce the observed reflectance and transmittance in forward mode. Tests of LEAFMOD confirmed that the model predicts realistic scattering and absorption coefficients for leaf material in the inverse mode and predicts reflectances and transmittances similar to laboratory values in the forward mode.

A canopy model was developed and linked with LEAFMOD, and LEAFMOD was modified so that it would compute leaf absorbance properties given the concentration of the main chemicals in the leaf (water, chlorophyll, protein, cellulose, and lignin). The linked models were used to simulate hypothetical trends in plant canopy reflectances resulting from such factors as leaf dry-out and chlorosis (chlorophyll depletion). Barry D. Ganapol, Department of Aerospace and Mechanical Engineering, University of Arizona, Tucson, collaborated with the Ames investigators on this project.

Point of Contact: C. Hlavka
(650) 604-3328
chlavka@mail.arc.nasa.gov

Amazon Ecology from Space

Christopher Potter

The degree to which primary production, soil carbon, and trace-gas fluxes in tropical forests of the Amazon are limited by moisture availability and other environmental factors has been examined using a new ecosystem modeling application for Brazil. A regional geographic information system serves as the data source of climate drivers, satellite "greenness" images, land cover, and soil properties for input to the NASA-CASA model over an 8-kilometer-grid resolution. This study describes the first published use of satellite remote sensing to simulate regional carbon and nitrogen fluxes and associated "greenhouse" gas emissions in the rain forests and savannas of Brazil.

Major findings of this modeling research include the following. Simulation results imply that net primary production (NPP) is limited by cloud interception of solar radiation over the humid northwestern portion of the region, with peak annual rates for NPP of nearly 1.4 kilograms of carbon per square meter per year localized in the seasonally dry eastern Amazon in areas that we assume are primarily deep-rooted evergreen forest cover. Regional effects of the conversion of Amazon forest to pasture on NPP and soil carbon content are indicated in the model results, especially in seasonally dry areas (see figure). Pasture plants and annual crops planted in areas of cleared Amazon rain forest are less tolerant of drought and less capable of tapping deep soil moisture supplies than the forest tree species that they replace. Comparison of model flux predictions

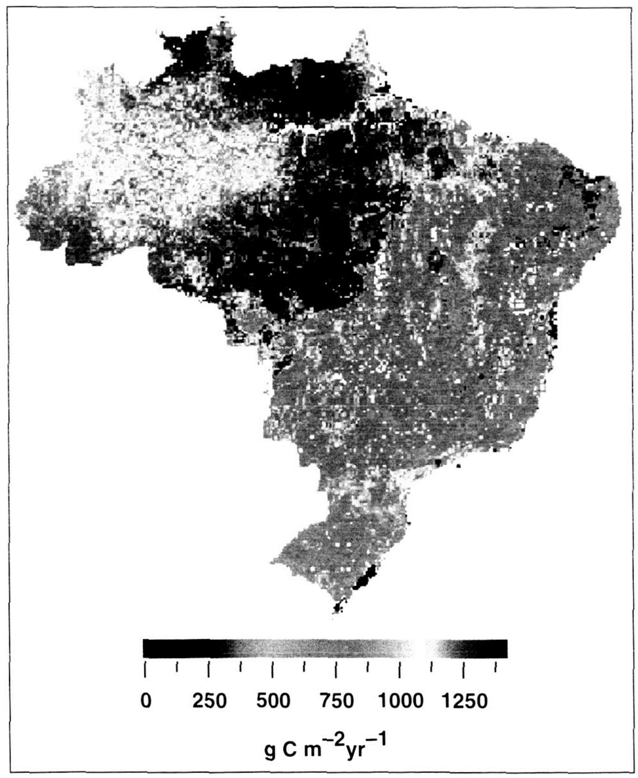

Fig. 1. Net primary production estimated at 8-kilometer cell resolution by the NASA-CASA model for Brazil, ca. 1990.